BULLETIN

OF THE

Society for the Promotion of Engineering Education

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EDITORIAL.

Inspection Trips.—The papers by Professors Magruder and Shaad should prove stimulating to those teachers who have not availed themselves of a very important adjunct to classroom instruction. The booklet prepared for use in connection with the trip of the O. S. U. students last spring was a most complete guide-book, a Baedecker in its class. Every member of the Society at that time received a copy. This guide-book, properly used, could not fail to produce a lasting impression as its statements were, one at a time, verified by actual observation. Professor Magruder's experience in the conduct of inspection trips has enabled him to bring them to a high degree of efficiency.

Professor Shaad's paper is based upon his experience in conducting short inspection trips at frequent intervals. As a teacher at the Massachusetts Institute of Technology he specialized in this work. The reports of the students were, in some cases, submitted to the department of English for criticism and a double benefit to the students thus resulted. This practice is in line with Dean Clark's suggestion printed in the October BULLETIN.

Interest in the Society's Work.—As an indication of the wide-spread interest in our proceedings, the following editorial from the *Philadelphia Real Estate Record* is of interest.

"The old, old issue of the book-learned theorist and the practical practitioner comes to light anew in the recommendation of a committee of the Society for the Promotion of Engineering Education on the subject of degrees in civil engineering. So many half-taught and obviously uninspired young men have been shunted out into the world by the colleges with the degree of civil engineer that the committee in question thinks the time has come to set up certain distinctions. The committee agrees that a four-year course should lead to the degree of "bachelor of science," but suggests that the specifying phrase, "in civil engineering," be added. After graduation, one year of resident work, in the judgment of the committee, should lead to the degree of " master of science," with the same specifying phrase, and two additional years, or three in all, to the degree of " doctor of science " or " doctor of engineering." The object is to check to some extent the exodus from the degree factories of the country of young men who go forth into the world as civil engineers with little more than the college parchment to substantiate their claims. Inasmuch as a movement is already under way to require civil engineers to be licensed after rigorous examination, as is done in the case of other professions, the better grade of engineers are seeking some means of preventing the profession from falling into a low estate.

"Any practical man knows that a diploma never did and never will make a successful civil engineer. The man born to the vocation of engineering gets the materials at college, the substructure in the broad domain of practical experience and the superstructure in his own virile grasp of the problems he is called upon to solve. Any arrangement that will so raise the standard of this preliminary training as to increase the practical development of the student must inevitably have the support of men who feel an honest pride in a glorious profession. There are too many haphazard, half-fledged engineers for the future good of the craft."

The Last Call.—Discussion intended for publication in the PROCEEDINGS must be received by the Secretary by December 1, if it is to appear in Volume 18. In other societies much of the most valuable discussion comes in by mail. Members at great distances from headquarters can thus be heard from and all of the members can have a chance to go on record with the results of their experience. So far the opportunity has not been made use of to any considerable extent, hence this word of caution regarding the importance of immediate action.

APPLICANTS FOR MEMBERSHIP.

BIXBY, F. L., Professor of Civil and Irrigation Engineering, New Mexico College of Agriculture and Mechanic Arts, Agricultural College, New Mexico..... 1910

BRYANT, J. M., Assistant Professor in Electrical Engineering, University of Illinois, Urbana, Ill..... 1910

BURGER, W. H., Assistant Professor of Civil Engineering, Northwestern University, College of Engineering, Evanston, Ill..... 1910

CHURCH, W. L., President and Consulting Engineer of the Ambursen Hydraulic Construction Co., 31 Chase St., Newton Centre, Mass..... 1910

CURTIS, W. W., Consulting Engineer, 355 Dearborn St., Chicago, Ill. 1910

GARVER, N. B., Instructor in Civil Engineering, University of Illinois, Urbana, Ill..... 1910

HASKELL, M. W., Professor of Mathematics, University of California, Berkeley, Cal..... 1910

KENDALL, H. C., Instructor in Railway Electrical Engineering, University of Illinois, Champaign, Ill..... 1910

MARQUIS, F. W., Associate Railway Engineering, Department of Engineering Experiment Station, University of Illinois, Champaign, Ill..... 1910

NOERENBERG, C. E., Instructor in Theoretical and Applied Mechanics, University of Illinois, Champaign, Ill..... 1910

PICKELS, G. W., Jr., Instructor in Civil Engineering, University of Illinois, Urbana, Ill..... 1910

VEDDER, J. N., Special Investigator in Engineering, University of Illinois, Urbana, Ill..... 1910

WILLIAMS, O. E., Instructor in Engineering Drawing, Ohio State University, Columbus, Ohio..... 1910

COLLEGE NOTES.

University of Minnesota.—Dr. Arthur Edwin Haynes, professor of engineering mathematics, after thirty-five years of continuous teaching, the last seventeen of which have been in the University of Minnesota, has been granted a year's leave of absence on regular salary. At the beginning of the present semester it was found by his physician that he had serious heart trouble which would compel his relinquishing his University work for the year in order to recover; and so the regents took the action above indicated. He is still confined to his bed, but hopes to be able to be out in a few weeks.

University of Pittsburg.—In June, 1910, the University of Pittsburgh dedicated the first of its new group of buildings to be devoted to engineering. Thaw Hall, the new building, is especially designed for the use of the engineering departments; containing about 39,000 square feet of floor space, and costing about $175,000. Thaw Hall, together with State Hall occupied by the School of Mines, places the engineering departments of the university in a very enviable position with respect to modern buildings.—The new equipment for the engineering departments amounting to a little over $100,000 in value is practically all installed, and is in many ways unique; and in every way practical. The faculty of the school of engineering was fortunate in knowing the courses they wished to give, and the apparatus necessary to produce the highest efficiency; thus, the new equipment is so arranged that every part of it is adapted to student use and to research. —Among the more important pieces of apparatus installed in the mechanical laboratory are a universal testing machine of 200,000 lb. capacity; a torsion machine for 3-inch shafting 20 feet long; a large air compressor for experimental work and for the operation of hammers in the forge shop; and a 100-h.p. experimental engine especially designed for this laboratory and made to operate as a simple, a four valve or a

compound engine. This engine is connected to a special boiler operated with natural gas and fitted with all modern conveniences for complete laboratory tests. The laboratory also contains a number of different types of gas engines with special arrangements for measuring the in-put and out-put.

South Carolina Military Academy.—At the last session of the State Legislature, the name of the South Carolina Military Academy was changed to The Citadel, The Military College of South Carolina. This institution was founded in 1842, and was modelled upon the U. S. Military Academy at West Point. Mathematics and engineering have always been the main branches of study. After a fixed course of three years for all students, there are elective courses during the last year, engineering, English, chemistry, and physics. The students generally divide between engineering and English. All graduates receive the degree of B.S.—It is proposed to get the authority of the next Legislature to grant the degree of C.E. to graduates who practice engineering for at least three years and have responsible charge of work.—There are now more than sixty of the alumni engaged in engineering work. The total number of hours in the four years of the course at the Citadel is about 1,200. The number of students this session is about 275. The discipline is thoroughly military. The commandant is an officer of the U. S. Army, and the honor graduate of each class is given a commission of second lieutenant in the U. S. Army.

Worcester Polytechnic Institute.—The institute has, this year, the largest registration in its history, 525 students, and more than double the customary registration a few years ago. —The course in shop management established by Professor W. W. Bird a few years ago, although a pioneer course in college instruction, has been for some time thoroughly established and is proving a most valuable course. It includes a study of shop costs; analysis of foundry and machine shop expense accounts, involving data from the commercial department of the Washburn Shops of the Institute.

THE UNIVERSITY OF BIRMINGHAM.

The members of the American Society of Mechanical Engineers, who recently visited England as guests of the British Institution of Mechanical Engineers, were given an excellent opportunity to inspect the University of Birmingham. In the course of the last five or six years, this institution has re-established itself upon grounds quite outside of the city. While only a portion of the plan projected has thus far been executed, the University has invested for buildings and equipment, in the neighborhood of two and one-half millions of dollars. It is the best housed and probably the most significant provincial institution in England. In welcoming the American visitors, Sir Oliver Lodge, the principal, said that in anticipation of their work at Birmingham, various representatives had travelled extensively in America, and that in the up-building of their institution they had sought to bring together the best features of the more successful American institutions. While this compliment was not without justification, the American visitor at Birmingham found much that he could study with profit. The orderly arrangement with which the plan of development of the institution as a whole has proceeded, the finished appearance of the various laboratories and the completeness with which they were equipped, were all matters which challenged his attention. In one respect, the problem of the English technical school is simpler than that of the American school. It is in the fact that they are required to provide for a fewer number of students. At Birmingham, for example, which is developed upon a plan as extensive as that of any of the technical schools of America, there are only about seven hundred students enrolled.—W. F. M. Goss.

The following paper was presented at the eighteenth annual meeting, Madison, Wis., June 23, 24 and 25, 1910. Written discussion is invited.

INSPECTION TRIPS.

BY WM. T. MAGRUDER,

Professor of Mechanical Engineering, Ohio State University.

The most ancient system of instruction is that founded on the oral lecture of the teacher to the scholar. When education was broadened to include the concrete and to teach of things, and not solely of thoughts, the lecture became illustrated; at first by such samples as were portable, and then by photographs, drawings and lantern-slide illustrations of the things themselves. The trouble with such flat representation is that the student so frequently gets a false perspective and a wrong conception of the thing illustrated. The laboratory method of instruction has added actuality and a feeling of realness to the work of the class room, because, not only is the imagination put to work, but the senses of both sight and touch are invoked and used. But the laboratory method, using models, samples, and miniature apparatus, is likewise conducive to false ideas as to size and proportion.

It is not to be expected or desired that an engineering college laboratory should possess bridges, filtration plants and sewage disposal works, or tipples, stamps and open-hearth furnaces, or yet metropolitan power, lighting and pumping stations, and all in full size. Fortunate is the faculty whose departments are well supplied with photographs, models and working drawings of such engineering structures, machines and plants.

As travel is a desirable complement to both geography and history, so are visits of inspection to class room and laboratory work in engineering. The history of the development of education in this country includes the introduction and increase of the use of inspection trips for the instruction of

students of all grades. In the cases of elementary and secondary education, the trips are strictly local and of only a half day's length at most. So far as known, extended, out of town, inspection trips of college students to engineering works were first inaugurated by the mining schools, some forty years ago, and Stevens Institute was the first mechanical engineering school to institute such trips (1881).

The history of the introduction of such trips usually runs the same way everywhere. Voluntary visits to local shops and works in the earlier years of the course were later made compulsory and were accepted willingly by all as being enjoyable, instructive, and helpful in classroom work. What was good educational practice in the elementary work ought to be equally good in the more professional work of the course, hence the extension of the system to the upper classes. To broaden the range of observation, visits to near-by localities were next included; and later, partly from dearth of such possibilities at home and partly to extend the experiences still further, trips were offered which required from several days to two weeks, or more, to complete.

The effects of such trips upon the student are manifold. (1) He learns something of what engineering really is. (2) From seeing the alumni at work, he obtains some idea of what will be expected of him. (3) He gains confidence in his instructors by seeing the plants and machines of which he has heard and been taught. (4) He obtains a complete differential of the engineering trades and the profession. (5) He sees bolts, and nuts, and shafts, and cylinders, and bridges, and waterworks, and furnaces, and generators, and transformers, larger and different from anything he has seen before. (6) They tend to decrease his conceit and modify his opinion of his superior knowledge, and that the peoples of other cities and states know a few things worthy of his consideration and respect. (7) He learns that engineering is not all pure science and that the commercial side is not infrequently the cause for the continued use of badly worn and antiquated machinery, buildings and structures, and that even

sentiment may keep a machine, or bridge, or building in commission when the best engineering judgment and business ability would require it to be replaced. (8) To a boy who has never been out of the county, it is worth as much as a trip to Europe to the boy of broader general training. Imagine the feelings of the Central American who sees snow for the first time, or the plainsman when he first gets a view of a mountain or the ocean; or remember your own sensations when for the first time you gazed on Niagara Falls, or a metropolitan skyscraper, and you may be able to imagine the feelings of awe and of fear which are engendered in the mind of the engineering student who looks for the first time into the power plant of a metropolitan office building, lighting station, or waterworks, and is told of its large capacity and power, or is whisked across a bridge a half mile long, or into a mine or down a shaft a mile deep. Ten thousand horsepower to the boy who has cared for one or more horses on the farm means much more in power than to the city-bred boy. There is a reality about the actual experience that no amount of study of printed matter will give, and when things cannot be brought to the student, it is well to take the student to the thing itself.

At the Ohio State University, the history of the introduction and evolution of compulsory inspection trips has been similar to that elsewhere. For the departments of mechanical and electrical engineering, the system seems to have been quite fully developed and the details of our practice and the results of our experience are here offered to the membership.

Beginning with local visits, week-end trips to Pittsburgh and to Cleveland were taken by Professor F. C. Caldwell and such of his students in electrical engineering as he could induce to go. In 1904, a more ambitious and extended trip was proposed for the upper classmen of the departments of electrical and mechanical engineering to Pittsburgh, Buffalo, Niagara Falls and Cleveland, and the next year to Chicago, Milwaukee, and Cincinnati. Everyone was pleased with the opportunities offered and accepted to see and learn on these

trips. The six-day out-of-town trips were under the joint management of Prof. F. C. Caldwell, professor of electrical engineering, and the writer. On the return from the 1905 inspection trip, the writer suggested that hereafter the inspection trips be made compulsory. The faculty, president and trustees approved of the proposal. Since 1905, the curricula in mechanical and electrical engineering have listed the courses somewhat as follows:

131. Inspection Trip to the East. One week at end of first semester, third or fourth years. Required in Mechanical Engineering. Prerequisite, Mechanical Engineering 103. (Mechanical Engineering of Power Plants.)

Given only in the even years.

Includes Pittsburg, Buffalo, Niagara Falls, Cleveland, and possibly other places. The entire expense need not exceed $32. A satisfactory written report upon the work of the trip is required.

133. Inspection Trip to the West. One week at end of first semester, third or fourth years. Required in Mechanical Engineering. Prerequisite, Mechanical Engineering 103. (Mechanical Engineering of Power Plants.)

Given only in the odd years.

Includes Chicago, Milwaukee, Gary, and possibly other places. The entire expense need not exceed $32. A satisfactory written report upon the work of the trip is required.

135. Written Report. Course of assigned reading upon processes of manufacture and power plants taken and reported upon by third and fourth year students in Mechanical Engineering as a substitute for Mechanical Engineering 131 on presentation of reasons satisfactory to the head of the department. One week at end of first semester, third or fourth years. Required in Mechanical Engineering.

137. Written Report. Similar to Mechanical Engineering 135 as a substitute for Mechanical Engineering 133. One week at end of first semester, third or fourth years. Required in Mechanical Engineering.

These statements of courses are the same for the departments of mechanical and electrical engineering.

It will be noted that these trips are required of all regular third and fourth year students in mechanical and electrical engineering, and that therefore both trips are taken by each student before graduating.

In deciding which works and plants to visit, we eliminate

all such as are but duplicates of those which can be visited at home. For this reason, railroad, car and locomotive shops, pressed steel car works, and certain iron works, pumping and electric generating stations are omitted. Admitting that we cannot visit all the works of a city in two days, we try to select the most notable ones of the greatest range of engineering manufactures and methods. Old as well as new plants and machinery are visited, in order that the student may get the proper perspective on each. Processes and machines which cannot be easily seen elsewhere are preferred to the normal steel mill, engine room and machine shop. That a tool, machine, engine, or works is "just like what we have at home," is the very best of reasons for quickly passing it by.

While the party travels as a whole, it frequently divides up into two parties, as will be seen by the bulletin, to visit mechanical and electrical engineering works; and these in turn are divided into as many groups or squads by classes, and alphabetically by names, as there may be guides.

We have always considered a printed itinerary necessary. At first it was a neostyled three-page folder, 5½ by 8 inches; then five pages, then a small printed folder, last year a sixteen-page folder 4 by 6½ inches; and this year it was a bulletin of standard size, 5¼ by 7¾ inches, published and mailed as a regular university publication. This year fifteen hundred copies were published by the university, three or more were given to each student, one was sent to each person, firm or company whose works were to be visited, or from whom we expected to receive any courtesy, to the parents and friends of the student if he so desired, to our mechanical and electrical engineering alumni, to the newspapers in the cities visited, to the larger dailies of Ohio, and to the editors of certain of the engineering papers.

As a preliminary to this paper, a copy of this BULLETIN has been sent by the society to each of its members.

The inspection trip is put on the student's registration card for the term just like any other subject. Six weeks' notice is given of the trip in the form of a preliminary an-

nouncement reminding the students that one week before starting he must deposit $25, and notify us of his choice of a room-mate and of a section-mate on the sleeper, of any rebates that he will expect on account of proposed absences from meals and rooms on account of staying with friends, of railroad tickets that he will not need, and of any other exceptions to be made in this case.

From the first the trips have been paternalistic in character. Their object being strictly engineering education, and only incidentally geography and the art of travelling, reduced railroad fares, hotel rates, special accommodations and facilities have been contracted for for weeks in advance. Good and nourishing food, comfortable beds, and quiet nights' sleep are of more importance than style and stopping at the more fashionable and higher-priced hotels. The party travel and stay together as a unit rather than having headquarters at one hotel for the instructors, and let the students shift for themselves at night and eat unwholesome food by day. Where street-car tickets are obtainable at reduced rates, and for elevated railroads, they too are included and distributed before starting. It is only by reducing the total cost for six days and nights to a minimum of $28 to $30 that such trips could be brought within the means of our students and be approved by our faculty.

Again, the saving in time, energy, and nerve power by buying fifteen hundred tickets, either as party tickets for railroad and Pullman service, or as individual tickets to be distributed before starting, and paying for same by check, is self-evident to any engineering or business mind. One thirty-minute experience in getting one hundred students lined up, one hundred tickets bought and odd change made, while everyone else waits, and with the assurance that a few belated ones will eventually be left, is enough to convince any one of the superiority of the communal system.

It is not always possible to get suitable meals at small places for one hundred persons unless they are ordered ahead of time. Street car, railroad and sleeper accommodations

should always be ordered ahead, or else not only will crowding result, but some of the party will be forced to come on later trains, sit up all night, or go without. Once the desirability of intrusting the finances or the party's trip to a treasurer is conceded, it immediately becomes desirable to put all the finances in his hands where anything can be saved in time or money, or any concessions gained. Our students are required to make a deposit of $25 to cover communal expenses one week before the trip begins. All other expenses he pays for himself. These may amount to five dollars. Any unexpended balance is refunded. This balance has ranged from twenty-five cents to three dollars. The eastern trip is the more expensive.

The examinations for the term close on the Saturday before the Sunday night on which the trip begins. On Saturday afternoon each student scheduled for the trip receives a large envelope which contains a neat nickel plated tag and leather strap for his luggage, and a celluloid button for his coat, on each of which are the words "Ohio State" and the student's individual number and the year, three copies of the bulletin, maps to large scale of the cities visited and sometimes descriptive advertising matter issued by chambers of commerce and by manufacturers, individual railroad tickets when for short rides, railroad and meal coupon ticket issued by the department, with numbered coupons which are required to be signed by the student, a copy of the "Preliminary Announcement," a copy of "Things to be Observed and Points to be Noted," or instructions on note-taking, and a sheet of "Some Suggestions to those who may need them." This last is of much value to the youth untrained in the art of skillful traveling.

We used to use standard Pullman sleeping cars, two in a berth, except in the few cases of those who were willing to pay the extra cost of a berth to himself. This meant loss of sleep and of adequate rest. For several years we have used only tourist Pullman sleeping cars, and assigned a berth to each man. The unanimous opinion of our students is that the

extra style, conveniences, and unappreciated comfort and ease in riding are not worth an extra dollar per night. We are fortunate in being able to get tourist cars in the district covered by central time as they are not carried by the eastern trunk lines.

Having this year a party of over one hundred persons and four Pullman sleepers, our cars went as a special train. This insured to us not only prompt service, but we were able to have the trains leave at reasonable and desirable hours, such as 9:30 to 11:00 P.M., rather than at 12:40 and 1:00 A.M. It meant three hours more of rest and possibly of sleep for each man.

By explaining in advance to the general manager or other officer of the company whose works are to be visited the object and exact hour of our visit, stating the number of persons in the party, obtaining a pass, and requesting the services of a sufficient number of competent guides, vexatious delays are usually avoided, and better guides obtained.

As a rule, the best and most painstaking guides are our alumni. Occasionally, good fortune favors one with a general superintendent or other high official. The worst guides are policemen who think it incumbent upon them to keep you out of all places of interest for fear they may be injured. The next worst are apprentices who are unfamiliar with even the geography of the plant, and have to be personally conducted.

As to the length of time to spend in each works, each room, or at each machine, this is open for the widest difference of honest opinion. When the special apprentices admit that after a year's residence they have not yet been all over the plant, it is futile to expect undergraduates to see it all in a half day or less. On such trips it does not seem to be advisable to go deeply into the details of design unless one instructor, or equally competent guide, accompanies each six to ten students. The easiest, efficient way seems to be to call attention in the bulletin of the trip to the things to be seen, either the general features and arrangement, or the specific details and peculiarities, then present the opportunities for them to

be seen, and expect the student to accept them and to ask such questions as may be in order. Such trips are of great value in training the powers of observation in getting true and accurate impressions and in training the memory to retain the same.

Our practice is to have one instructor accompany each twenty to thirty students. The lower figure is much to be preferred for best results. Besides managing the details of the trip, the instructors must see that the services of even competent guides are supplemented by suggestions from them as to what is best to see, to stay at longer, to study in detail, to pass by rapidly, or to omit entirely, remembering that what may be of greatest interest and novelty to him may not be so to the student.

The students have always been required to take notes of the trip, and to hand in the original notes with a carefully written report of the trip, two to three weeks after the return. One of the results of the system was that many students being inexperienced and non-judicial in determining the value of engineering data would copy verbatim the name-plates of generators and possibly be unable to tell anything about the machines themselves. Engineering myopia, we call it. Others would sum it up as if the report were an inventory, or of a statistical nature. The amount of information given in the "itinerary of the trip" has been gradually increasing. To try to remedy the defects in obtaining reliable information and in taking notes, Professor J. H. Hunt, for the department of electrical engineering, and the writer, tried the experiment this year of putting into the hands of the students before leaving much detailed information of as reliable a nature as was obtainable. The students were still required to take notes and hand in reports. Fewer notes were taken, the reports were shorter than heretofore, and as a rule contained facts and opinions not given in the bulletin. These reports were gone over, corrected by the department, and required to be revised by the student and returned where necessary. The consensus of opinion of instructors and students is

that the longer and more complete bulletin is to be preferred because it saves time which can be more profitably used than in taking notes which may be quite inaccurate, even if not absolutely wrong. The bulletin should tell the student what he is expected to see, and he should be required to make only such additional notes as to facts and opinions stated to him, and of his own impression and opinion, as may be suggestive and valuable. As a basis for note-taking, it must be borne in mind that the statements printed in the bulletin are obtained from papers read before one of the engineering societies, or from catalogues and advertising matter of the company or city, or from direct knowledge, and that in many cases, it is issued by the company; whereas, the statements made by young, inexperienced but enthusiastic guides are not infrequently inaccurate, misleading or wrong. Just where the happy medium is between taking no notes and voluminous notes is a question akin to the one of how much time shall be spent at each works, and must be decided differently in different cases.

On the return from the trip, a set of questions is issued and answers invoked from the students as to their opinions as to what can be done to improve future trips, what visits should have been omitted, shortened or extended, the best and the poorest hotel and restaurant accommodations, the most and the least interesting works visited (a) from professional value and interest, and (*b*) from entertainment and amusement.

From the answers received for two years, it appears that the students are of the opinion that the trip is well worth the time and money, and that it is a strenuous undertaking of much educational value. The advice of students who have been on a trip to those who have not and think they cannot afford to go is that "you cannot afford to miss it." This is evidenced by the few students, from three to five per cent., who take the alternative or reading course.

The reading course requires the student to do one of three things; to spend sixty hours in the library looking up references concerning the places, works and plants visited by his

classmates, and so visit them by proxy, or concerning some special subject of interest and value to himself, or to make a corresponding series of visits to similar places in his home town, with or without library reference work, and in every case to report on the results of his study.

The trip this year required about 125 man-hours of preparation, six days for each of four instructors while on the trip, stenographic labor on 375 letters, $8.97 of postage, and the labor of reading and grading one hundred and five notebooks and reports. The expenses of the four instructors are paid by the university. The special or extra cost to the university over and above salaries amounted to about two dollars per student. From these statements it will be seen that such trips are not restful outings for those in charge, but on the contrary, are strenuous, fatiguing and require special abilities.

At the Ohio State University, all of our ceramic, mining and chemical engineering students have out-of-town trips which are required of them for the degree. In a limited way, the summer camp of the civil engineering students answers the same purpose. Inspection trips to engineering works and plants off of the campus and out of the college town can be arranged just as effectively for the students of one department as for another, but it means much work for some one.

In considering the subject, it must be remembered that these trips are for engineering education and that practices followed with twenty volunteer students and two instructors are not equally efficient with over one hundred students and only four instructors, and secondly, that the printing press has taken the place of the town-crier.

Written discussion on the above paper, if received before Dec. 1, will, with the approval of the Editing Committee, be printed in the PROCEEDINGS. Contributions should be brief and interesting and should add something to the subject.—ED.

The following paper was presented at the eighteenth annual meeting, Madison, Wis., June 23, 24, 25, 1910. Written discussion is invited.

INSPECTION TRIPS FOR TECHNICAL STUDENTS.

BY GEORGE C. SHAAD,

Professor of Electrical Engineering, University of Kansas.

Inspection trips for technical students are organized for a variety of purposes, chief among which are: to furnish inspiration to the students and allow them to become acquainted by actual observation with the large variety and the great magnitude of modern public service enterprises and industrial establishments; to familiarize students somewhat with the details of construction, operation, or method of manufacture of machines, or the preparation of materials with which they may have to do in their advanced school work and after graduation; to furnish material for practice in the writing of technical reports, the preparation of descriptive reports forming excellent training along this line. An extensive and well-organized trip is of benefit to the instructors as well as the students as it gives them an opportunity to observe the general features and operations with which they have become more or less familiar through reading; it furnishes a fund of details to be drawn upon in regular instruction work; and it should be as much of an inspiration to the instructor as to the student. There is usually an opportunity for the instructors to meet engineers, and superintendents of the more important plants, and such opportunities should never be neglected. Finally, an opportunity is afforded during the long rides and the frequent conferences for instructor and student to become better acquainted with one another than is always possible in the routine work of the school.

Much may be learned from any power plant or other industrial enterprise, no matter how small or isolated, but when the main object of the trip is inspiration, the larger the es-

tablishments and the greater the variety of power plants, the greater the benefits derived, consequently such trips are usually arranged to cover considerable territory and to include such centers as Pittsburg, Chicago, Buffalo, New York, etc. There is much to be derived from becoming acquainted with new territory, consequently it is desirable for students in the schools of the middle west to arrange for their inspection trips among the eastern cities, but this is not at all necessary. The majority of extensive trips include Niagara Falls and vicinity and an opportunity to examine the developments in this region is easily worth the cost of the trip.

For inspiration purposes the plants and industries should be extensive, should present a large variety, and should be fairly representative of their class. For teaching details or furnishing material for a carefully prepared technical report, on the other hand, the plant should not be too large, and instead of covering any considerable amount of ground in the alloted time, the student should be given every opportunity of examining the plant and gathering detailed information in regard to it. Too large a plant or too great complication is discouraging to a student required to make a detailed report, and the benefits to be derived are greatly reduced if the task is too much beyond him. After some experience has been gained in examining plants and preparing written descriptions of them, the larger and more complicated power houses may profitably be assigned.

Any inspection trip loses greatly in its efficiency unless it is carefully organized in all of its details, and the members of the party should be held to a reasonable observance of the schedule. The ideal party should not include too many students but the number is not limited provided the organization is careful and complete and enough instructors are furnished so that there shall not be more than about eight students to one instructor. In large parties the students should be assigned to certain instructors and directed to keep in touch with the assigned instructors during the trip, and to accompany them when it is necessary or desirable to divide

the party into smaller groups. This facilitates the dispensing of information and avoids delay at the entrance to power plants or other industries. When the party includes students from various courses it is often desirable to have it divided according to these courses and at certain times to visit entirely different establishments. As far as possible all passes should be secured in advance and a detailed schedule placed in the hands of each member of the party.

Inspection trips, formal or informal, are taken by the students of all engineering schools and the students should be encouraged to make inspections by themselves whenever practical. It is not probable that the desirability of inspection trips will be questioned but in the practical application we come immediately to the question as to whether or not they should be made a part of the required work. And a second question, at what period of the course should they be scheduled? The writer believes that the inspection trip should be a portion of the prescribed work for engineering students and that excuse from it should be as carefully guarded as excuse from any prescribed work. An objection to this lies in the fact that the expense in connection with such trips may be a considerable hardship for some of the students; but the required trip need not be an extensive one, in fact it can be made a series of short trips in some localities, and a longer trip may be made optional. Any time during the senior year or in the latter part of the junior year is quite suitable for the inspection trip as it is usually organized. When more of the observation of details is desired the later in the course the trip can be taken the better, but all things considered, it is perhaps as well to arrange for the inspection trip near the close of the junior year. On account of the fact that the engineering courses are so crowded it is not uncommon to find the inspection trip so scheduled as to occupy a part of some vacation, and it is undoubtedly better to arrange for an extensive trip near some holiday time, preferably just before it, then to break into the middle of a period of regular work.

A great deal of care is necessary to see that students get

as much as possible out of the inspection of any plant or industry. The student should be given as much general information in regard to the particular plant as possible, and questions liable to come up should be anticipated as far as practical before he enters it. The individual parties should not be so large that questions cannot be readily asked and as readily answered while making the inspection. The order in which students are conducted through the plant is important. Proper classroom instruction will cause the men to be on the lookout for different things they have learned about but have never before had the opportunity of observing. Careful and systematic note-taking is necessary where details are desired, and information not readily available from inspection should be promptly and accurately given by the instructor in charge. Daily conferences with the students for the purpose of discussing the plants visited each day add very materially to the benefits to be derived from inspections and the student's notes should be complete at the end of each twenty-four hours. Inspection trips carried out according to the above arrangements are hard work both for students and instructors, but the writer has as yet to find a student who regretted taking such a trip.

A written report of some nature should be required and considerable care should be exercised in the review of this report. It should be criticised from the standpoint of organization and arrangement of material, of facts presented, of English used, and of the appearance of the report as a whole. As already stated, the preparation of technical descriptions of power plants gives excellent training in the writing of engineering reports.

Inspection trips are as varied as the institutions which offer them and they are seldom conducted in just the same manner two years in succession. The writer has had considerable experience in connection with inspection trips, both local and extended. At one institution with which he has been connected a series of three or four local inspection trips with descriptive reports covering the plants visited were re-

quired, and a more extensive trip was offered as optional. Students not taking the optional trip were expected to do extra work in place of it. The local trips were taken for the purpose of gathering details and they were carefully organized so that the students could see and learn as much as possible while at the plant. For the first trip a small and simple plant, such as some isolated plant, was selected. The object of making the inspection, the general features of the particular plant to be visited, an outline of some good method of procedure in making the inspection and general instructions in regard to the written report were furnished to the students previous to their visit to the plant. Several sections were organized so as to have but a small number of students in the plant at the same time. The party was conducted through the plant according to some definite plan. In steam plants it was usually desirable to start at the fuel supply and end at the point where the feeders left the station; plenty of time for taking notes was allowed; and careful attention was given to individual questions, the student preferably being directed as to how he could find answers to his own questions. By beginning with a small plant where each detail could be carefully observed, and criticizing the written report from the standpoint of material included and the relative importance of the different features of the plant, as well as its general makeup, by the end of the year, aided by the advanced classroom work, the majority of the class could write a credible description of a fairly complicated plant after a personal inspection occupying from two to four hours.

Inspection trips without personal supervision of instructors are valuable but, as is always the case, the lower the grade of the student, the more essential is the personal supervision. In the school with which the writer is at present connected a series of technical reports are required from all engineering students and for the electrical students we try to see that at least one of these reports shall consist of a technical description of some power plant or industry, written from the student's personal observation of the same. After reading a

few of these reports one can better appreciate the desirability of personal supervision of the inspection.

When the number of students in a course is not very large many modifications of, or substitutions for the ordinary inspection trip may be introduced, and it is hoped that a description of some of these modifications which have been introduced, and something of the results accomplished, may be given during the discussion.

The writer would like to sum up his opinion of inspection trips as follows:

They are worth while and, in some form, should be made a portion of the required work.

Careful organization and supervision are essential.

Conferences and written reports add very materially to the benefits to be derived and should be required.

Finally, the writer would like to take this opportunity to express his very great appreciation of the courtesies always shown him and his parties by those in charge of the establishments he has visited; without the cooperation of those in charge of the power plants and industries, inspection trips would indeed be a failure.

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The following paper was presented at the eighteenth annual meeting, Madison, Wis., June 23, 24, 25, 1910. Written discussion is invited.

CHARACTER TRAINING.

BY JOHN PRICE JACKSON,

Dean of the School of Engineering, Pennsylvania State College.

At a recent important meeting of high school principals in one of the eastern states, an assertion was made, and vigorously supported, that college students do not receive sufficient training in morals and character. This statement was upheld by pointing to many examples of unsatisfactory records of graduates from our reputable institutions. The principals were of quite uniform mind concerning this subject. Many others, prominent in public and industrial life, seriously criticize the colleges of the country in the same manner as above. We, of the industrial teaching fraternity, do not credit many of these statements, as they are exaggerated and ill founded; but nevertheless, it must be admitted,—the criticism being so general,—that there is likely to be at least some small foundation upon which they are based. I, myself, have met seniors and juniors from more than one institution who had no adequate comprehension of what constituted an honorable fulfilment of a contract. Moreover, it is not at all uncommon for students in many of our institutions to consider that cheating in college work is justified by the system of espionage in use, and that certain varieties of low morals and of dissipation are to be considered a credit to a man rather than otherwise.

Instructors who prepare men for the engineering profession, of course, agree that there are three prominent divisions in a student's development: namely, of the character, the mind, and the body; and that these three divisions are important in the order in which they have just been named. The colleges of the country have worked out magnificent

courses and methods for preparing men mentally for future use. They are also, by a system of playgrounds, regulated sports, and gymnasium work, beginning to give some systematic and logical attention to the building up of the student's physical health and strength; but however much is being done individually by members of faculties, through example, advice, and otherwise to develop character, the work is largely of a voluntary and sporadic nature. This neglect of the most important division of training is surprising, as neither will the professor in charge recommend graduates who lack proper character, nor will manufacturers or industrialists knowingly employ such men.

Have we not, then, reached a point in the development of the American schools of applied science where a mere general understanding among the teachers that they must endeavor to improve and perfect the character of the students under them is inadequate? And is it not possible, in order to fix the responsibility and duty of instructors, to include in catalogues, in printed instructions to faculty members, and in other ways to announce specific instructions with regard to this most important element of the training of young men?

Is it not possible to require each instructor, as part of the regular scheduled work, to devote a small specific portion of his time, to be taken from one of each four or more periods of a class, to some subject having direct bearing upon the development of character? Further, cannot the subjects upon which he is to talk be carefully planned and scheduled in order that, through the four years of the college course, the student will have had the advantage of a logical and connected study, relating more particularly to human character and life? It is possible, of course, to have separate lectures, say once a week or less often, upon the subjects under consideration, rather than to have short talks by all instructors, but this, though desirable, and I believe now a practice in many institutions, is not in itself sufficient for two reasons: first, it does not tend to encourage the growth of the proper sense of responsibility for character development throughout the

whole instructing body; and second, it fails to give the students the personal touch and aid which they might otherwise receive through the talks of instructors with whom they are intimately acquainted by contact in the small sections of recitation classes.

During the Freshman and Sophomore years, the teachings could, in large measure, be based upon incidents in the lives and works of great engineers and scientists; thus not only giving opportunities for the development of the character of the students, but also furnishing them a source of inspiration and professional enthusiasm. During the Junior year, the talks might, with propriety, treat of the general subject of law, and the attitude which a citizen should bear to it. This could readily be made interesting and practical by illustrations drawn from the current press and reviews, especially those relating to industrial corporations and individuals connected with industrial works. In the senior year, the lectures might suitably deal with the subject of the relations of a man to his particular organization, with particular emphasis upon such principles as are necessary for properly treating one's fellows. These suggestions are purely tentative; indeed there is such a variety of material which is of vital interest and import to the lives of students of engineering that a suitable schedule could readily be made up by the faculties of our technical schools. It is to be understood that if such a system were put in force, the instructors would be expected to prepare this work accurately and with as much thought and study as they do their regular class work. The instructor who does this work, does not need to be a highly trained preacher of morals, any more than he need be a highly specialized expert in railroad engineering to teach trigonometry. The work should be so planned that the student may gather the desired impressions from the incidents and facts of history, biography, industrial undertakings, and current life. Pure moral preachment, as such, might well be ordinarily avoided: first, because it is not likely to be sufficiently impressive or enduring; and secondly, because it is difficult

to command the proper meed of respect for opinion unsupported by indisputable facts. Any instructor who is properly fitted to teach college students should be able to do the work proposed if properly planned.

This paper is not intended to be-little, in the least, the important development of character accomplished through the discipline and studies of the ordinary technical course of four years, but it does seem that enough is not accomplished; and that as a result many men leave college unable to deal "honestly, justly, and magnanimously" with those who may be in their employ, their colleagues, or their superior officers, and are unable to take their proper places in the social order of our present civilization; nor does it appear that sufficient direct emphasis has ordinarily been devoted to the subjects of loyalty, good morals, accuracy, decision, promptness, energy, enthusiasm, obedience to law, and the many other elements which determine the social and industrial usefulness of a man. It can scarcely be denied that by giving character training the dignity of a place upon our college curricula, and in our university publications, much may be accomplished toward raising the general level of the quality of the men who are graduated; and further, that so long as the work of character training is left almost exclusively to the Young Men's Christian Association and the college preacher, and is so far divorced from the regular college curricula, as is often the case at present, criticism of the character of our college graduates will undoubtedly continue with some basis of justice.

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The following paper was presented at the eighteenth annual meeting, Madison, Wis., June 23, 24, 25, 1910. Written discussion is invited.

NOTES ON THE GERMAN TECHNICAL UNIVERSITY.

BY GEORGE H. SHEPARD,

Dean of the L. C. Smith College of Applied Science, Syracuse University.

PART II. THE FACULTIES.

Thus far I have discussed the German system as it affects the student. In what follows I shall discuss it as it affects the faculty. I have pointed out that the German engineering student is left very much to his own devices both in school and in life; also that the American engineering teacher must give closer attention to his students in order to accomplish in four years what the German does in five, and that starting with better prepared students. Not only does the German professor give less attention to each student than the American, but he has fewer students to teach. For the last semester of 1908–1909, the numbers of faculty members and students in the six German technical universities visited by me, were as follows:

School.	Total No. in Faculty.	Total No. of Students.	Students per Teacher.
Hanover	107	907	8.5
Charlottenburg	402	3,142	7.8
Dresden	193	1,000	5.2
Munich	171	2,820	16.5
Karlsruhe	116	1,256	10.8
Aachen	125	721	5.8
Total	1,114	9,846	8.8

I doubt if there is any American engineering college that has as large a faculty in proportion to its student body as is shown by these figures. The result of all this is that the German teacher is much less burdened with work of instruc-

tion and administration than is the American, and that consequently he has much more time to devote to other things. It is thus that many of the German professors are able to carry on lucrative consulting practices. The teaching position affords them at once leisure and an office and the use of extensive equipment. A university professor is very highly respected in Germany, so much so that the holding of such a position is in itself a good foundation on which to build a consulting practice.

All of these inducements are present in America in a very much less degree. Much of the consulting work is in the hands of large companies, with which the individual professor competes with difficulty. His college probably affords him very little leisure and an indifferent equipment for consulting work. As to social and professional standing, the career of a college professor is respectable; and that it all that can be said for it. Most of our people regard a college professor as an amiable gentleman of eccentric habits, who is likely to get lost if he goes out on the street alone; while, if he uses his academic title, they take him for either a dancing-master or a barber. In consequence, while there are some American engineers of large reputation engaged in teaching, our eminent engineers are more likely to be found in practice; while the German technical universities are able to attract to their faculties men of the very highest rank in the engineering profession.

It must be conceded that students are more likely to profit by instruction from a teacher whose professional attainments they highly respect, and whom they feel to be a first-hand authority in his subject, than from one whom they consider a mere conduit, whose only function is to bring to them the knowledge which he has himself received from others. However, it should be said on this point, that the teaching by the eminent men of the German faculties hardly extends beyond giving their lectures. Aside from that the work of instruction is almost entirely in the hands of assistants, of whom there are many. These assistants are apt to

be young men, of little practical experience; and the salaries which they receive are very poor, usually not over thirty dollars a month. They are therefore compelled to have some other source of income. Excepting those candidates for the doctor's degree who take an assistant's position merely to help out, and those men of means who take the position in hopes of winning a professorship, the assistants are driven by necessity to do some outside professional work in addition to their teaching. They are therefore ready at hand to assist the professors in their consulting work, as well as in their teaching; or, if they do not find employment in this way, they must do some kind of work for outside employers. It thus comes about that practically everybody in a German technical faculty, from the rector down to the youngest assistant, is engaged in practical work simultaneously with his teaching. This system certainly has the virtue of keeping the faculty in touch with practice; and this must be done in some way, for, if an engineer after becoming a teacher withdraws himself from the practical exercise of his profession, he soon ceases to be an engineer and becomes a mere theorist, and his teaching becomes correspondingly bookish and impractical.

We also must keep our teachers in touch with practice; but it would not do for us to attempt it in the same way. The salaries that we pay to our instructors and assistant professors are already so low that we are barely able to attract men of sufficient ability from the industries. That we can do so at all is largely due to the fact that some men have such a strong bent for teaching that they are willing to follow it, even at considerable material sacrifice. Then we occupy our men so fully with college work, that almost the only opportunity that they have for outside work is during the summer vacations and the leave of absence every seventh year allowed by many of our institutions. It is in fact the summer vacation and the sabbatical year that save the situation for us in this respect; and, as far as my own observation goes, our engineering teachers have been faithful in the

use of these opportunities; and I believe that there are few among us who can justly be criticized for allowing themselves to get out of touch with practice. However, it is obvious that, if a teacher is exclusively occupied with college work during his attendance at the institution, and must devote his times of freedom to work in practice in order to keep up, his time for original investigation is reduced to nothing.

In the last respect the Germans are far ahead of us. Even in their consulting practice, the professors often have occasion to do work of research value, and, as it is desirable for the professor's reputation that such results should be published, provided the client has no objection, the profession at large is more likely to benefit by them than if they had been obtained in the private laboratory of the client, since he has no interest in publishing them. Also, beside their consulting practice, the German teachers of engineering have time to engage directly in research; and their published results are sufficient evidence that they do so largely and effectively. At this point the magnificent equipment of their institutions again comes into use. When a man undertakes original investigation, he cannot be too well equipped with apparatus, libraries, and collections. Further, the German professor has financial support for his investigations. Each head of a laboratory has a fund available, directly from the institution, for research work. Beside this, the Jubilee Fund of German Industry provides an endowment of about $360,000, of which the income goes to the same purpose. Also the Verein Deutscher Ingenieure spends about $10,000 every year to aid original investigations in all the German technical universities; and results of these can be read in any number of the *Zeitschrift*. If we examine our own conditions in this respect we find them in painful contrast. In the first place in most of our engineering colleges the teachers have practically no time for research. They have indeed a little spare time, but it comes in scraps of half an hour or so at a time. Now there are very few new engineering problems that can

be solved without some use of the experimental method. Even where a result can be reached by reasoning alone, it requires to be checked by experimental test before confidence can be placed in it. To set up apparatus and secure from it results of value, a man must have continuous hours of uninterrupted time.

Then, original investigation has adequate financial support in few, if any, of our technical colleges. I recall a case where a professor in one of our technical colleges which enjoys a reputation among the first, after getting well along in the investigation of a problem of great practical interest, was obliged to desist from lack of funds, and to employ his spare time, not in original work, but in trying to beg money for it from those industrial concerns that would profit by his results. My knowledge of the matter extended over a year or two after the stoppage of work; and, up to the end of this time, work had not been resumed. Considerable research is indeed being done in this country; but most of it, by the industries themselves; and naturally their results are usually not for publication. Some investigation is done by the government, and of it the public usually has the benefit. Finally our engineering teachers do some research, in spite of the difficulties of their situation; and for this all honor is due them; but it cannot be denied that, compared to the German technical universities, our institutions are barren of new knowledge. I feel strongly that this matter ought to be remedied. Aside from the benefits of research by the engineering colleges, to the profession at large and to the industries, which have been briefly indicated above, for the sake of the professor's own self respect and of his authority with his students, he ought to do research and be himself a source of new knowledge, instead of being a mere conduit from such sources to his students.

I have pointed out that the first step in the desired direction is to afford our faculties a relief from the burden of teaching. I feel that this relief ought not to come from neglect of our students. I feel also that our teachers ought not

to desist from taking positions in practice during their proper periods of absence from their colleges. Therefore relief can come only be increasing the numbers of our teachers and by affording them more clerical assistance. My own opinion is that the relief of our faculties in this respect will do more to bring able engineers into teaching and to keep them there, than anything else that can be done. It will take a great deal in the way of salaries and old age pensions to make ambitious men satisfied, as a career, with merely passing along the rudiments of learning. On the other hand, if the college affords the professor a respectable living for himself and family, and the leisure in which to make a reputation by original investigation, he ought to work out his own salvation or be damned for failure. Second only in importance is the provision of adequate financial support for the work of research. In both respects, the fundamental difficulty is a financial one. On this point it is interesting to see that the German technical universities, situated in a country financially poorer than ours, are government institutions. They have received some assistance from private benevolence and from students' fees; but the bulk of their support comes from the state; and it is necessary only to visit them, to see that their support is generous.

In this country a few states give good support to engineering colleges; but, in the main, we have been content to rely upon the generosity of private individuals. Now we ought to realize some facts: (1) That prosperous industries are a public necessity; (2) that our industries cannot prosper without the services of highly educated engineers; (3) that it is impossible for students themselves to bear the heavy expenses of their engineering education; (4) that it is therefore a public necessity that a sufficient number of young men should be enabled to secure an education for the engineering profession; and (5) that a public necessity should be paid for from the public purse.

Good use can always be made of any money that may come from private sources; and we should always receive such help

with due gratitude; but we ought not to depend upon private benevolence to supply us with the higher technical education, any more than we depend upon it to provide us with a water supply or to maintain the board of health. In short, I advance the proposition that all of our states ought to follow the example of the German states and of some of our own, and undertake the support of adequate technical colleges. To accomplish anything along this line would require a campaign of education by this society and all others that are interested in the matter; and, at best, results could not be expected for a long time. Therefore, I hope that our generous private benefactors will appreciate the needs that I have pointed out above, and will not allow us to await tardy public aid, for the relief of a bad situation.

The above has naturally been a discussion of the differences between the German system and our own; but on the whole, in my visits to the German institutions, I was impressed with the similarity of their methods to ours, rather than by the differences. It was encouraging to see that others, for whose practice we have cause for the highest respect, working independently from us, have evolved a system so much like our own. Nevertheless I think that, in some details that I have pointed out above, our methods of instruction can be improved by closer conformity to the German model; while the obstacles that lie in the way of research by our engineering teachers, I think should be removed at the earliest possible moment.

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ENGINEERING INSTRUCTION AT THE IMPERIAL PEI-YANG UNIVERSITY, TIENTSIN, CHINA.

BY WALTER H. ADAMS,

Professor of Mechanical Engineering.

The object of this paper is to give an idea of the work in engineering education that is being done in China at the present time. This paper is confined to the Pei-Yang University—as it is the one the writer is most familiar with—but further description will be given in future papers. This paper will be confined entirely to the engineering work of the University.

The Imperial Pei-Yang University is situated in the province of Chili just outside the limits of Tientsin, the largest city in North China and the port of the capital, Pekin. The University, although called imperial, is really a provincial university, as it receives all its support from the provincial government of Chili Province. The courses of study and method of government, however, are under rules given by the Imperial Board of Education in Pekin. All the students are supposed to be graduates of the provincial high school at Pao-Ting-Fu, in the same province.

The University was first organized in 1895 under the patronage of Wang Weng-shao, who was, at that time, Northern Minister and Viceroy of Chili Province. A preparatory department with a four-year course was connected with the University, as the secondary schools were not organized then.

The collegiate department was arranged to give four-year courses in law, and in civil, mechanical and mining engineering. The site of the University was in what are now the foreign settlements of Tientsin. The first class was graduated in 1899. The Boxer trouble in 1900 caused a suspension of the

work for some years. The university buildings were taken by the German troops and used as barracks.

Work on a reorganized university was immediately begun in 1902 when the control of the Tientsin government was returned to the Chinese. The site was removed to a ruined arsenal at a small place called Wuku, on the Pei Ho (North River), about six miles from the foreign settlements of Tientsin. Building work was completed so that educational work was started in April, 1903. The teaching work was entirely preparatory at first as the former students were scattered and could not be collected to form the collegiate part of the University. At the end of two years (August, 1905) students were admitted to regular work in the courses of law, and civil and mining engineering.

Viceroy Yuan Shih-k'ai sent part of the students to America to continue their studies in 1906 and again sent more in 1907. All of these students were under the charge of Dr. C. D. Tenney, who was relieved from his work as president of the University to take charge of them.

This wholesale sending of students to America seriously interfered with the work of the University. (The main difficulty has been to secure students with the proper training to undertake the work of the University.)

While the University had been growing, as outlined above, the secondary schools had been organized and the first group of students were brought from the Pao-Ting-Fu High School, although they had not completed their course. These students were combined with students from the Wu-Cheng school in Pekin to form a preparatory class. This class was finally admitted to the University as a regular class in 1907.

During this construction period a normal course and a language course were installed but were finally given up.

In the spring of 1908 the details of the courses were submitted to the board of education in Pekin for approval. The board pointed out that, according to imperial regulations, general and technical subjects of study ought to be kept apart in the curricula of high schools and universities. This made

necessary a rearrangement of courses to meet both the board's requirements and the qualifications of the students then at the University. Special schedules were arranged for all the classes then in the University and a regular schedule was given for all future classes.

Another class was brought from the high school to form a preparatory class in the University in 1908 and this class was admitted to regular university work in 1909.

The teaching staff is now composed entirely of Americans and Chinese. The first president of the reorganized university was an American, Dr. C. D. Tenney. Other nationalities have been represented in the faculty at various times to teach languages, but all such work is now abolished. Our present president, Mr. Wang Shoh-lian, although receiving his education in England and never visiting America, has recruited the faculty entirely from American institutions. The result is a faculty of ten men who come from all parts of the United States, although the majority are from the Eastern States. Harvard has two representatives in the law department, Massachusetts Institute of Technology one each in the civil and mechanical engineering departments, University of California two in the civil engineering department, Columbia and Leland Stanford universities one each in the mining engineering department and Johns Hopkins Universities one in the law department. There are a number of Chinese teachers in addition. One of these is an assistant professor in civil engineering and conducts his classes in English. The others are not connected with the engineering departments and have no knowledge of English.

Money to carry on the work of the University has been granted quite freely by the various viceroys of Chili Province. They have been much interested in the work which has been done.

The present courses in engineering, as approved by the board of education, are three-year courses in civil and mining engineering. The subjects taught, except Chinese classics, are purely technical with no attempt to give culture studies.

Therefore it is possible to give all the essential work in an American technical course in the three years. Much better work, including culture studies, could be done in a four-year course, but the board requires the work to be completed in three years.

The University is not allowed to give degrees. After completing the courses at the University the students go to Pekin to take a series of examinations covering the work they have done. (No one knows just what the examinations will be like as it is a new regulation.) All the drawings, notes and examination papers given at the University are sent to Pekin at the same time. If the students pass these examinations, they are granted Chinese degrees by imperial rescript. The passing mark required in the examinations is 60 per cent.

The school year is ten months, divided into two terms. Recitations are held six days in the week with recitation hours from eight to twelve and one to four. The total number of hours assigned per week varies from 30 to 35. This is much higher than the American average and means less time for preparation and more work in the class room. Every student is expected to spend the time between 7 and 10 P. M. in study and as much more time as he thinks is necessary.

The students live at the University and are not allowed to be absent from any recitations without special permission. A certain percentage is deducted from the yearly average for each hour of absence.

The University supplies all books, drawing materials, chemicals and other supplies free of charge. The students are allowed to buy their books at half price upon leaving the university. Originally the students were paid to attend the University, but now the payments have been stopped and a small fee is charged. The fee is to be raised as soon as the students are able to pay a larger one.

The students have a large, well-equipped gymnasium and athletic field. They receive instruction in athletics and games twice a week from an American Y. M. C. A. teacher. They

are interested in tennis, basket ball, association foot-ball and track events. Base-ball and collegiate foot-ball do not seem to interest them. The athletic work is not compulsory.

The approved courses of study with the number of hours per week are given below. These courses are given to the lowest class only, at present. The two upper classes in each course have special schedules approved for them by the board of education.

CIVIL ENGINEERING COURSE.

First Year.

First Semester.		Second Semester.	
Mathematics above calculus	2	Mathematics above calculus	2
Applied mechanics	3	Applied mechanics	3
Geology	5	Strength of materials	2
Masonry construction	3	Masonry construction	3
Surveying	6	Surveying	6
Freehand perspective drawing	4	Seismology	2
Mechanical drawing and descriptive geometry	6	Descriptive geometry and isometric drawing	6
Plotting (survey drawing)	3	Topographical drawing	3
Total	32	Plotting	4
		Total	31

Second Year.

Elements of mechanical engineering (machine design)	4	Steam and gas engines, boilers, etc.	2
Bridges	4	Mechanical and metallurgical technology	2
Road engineering	2	Bridges	4
Railroads	3	Railroads	3
Hydraulics	3	Hydraulic machinery	2
Building construction	1	Building construction	1
Elements of electrical engineering	2	Geodesy	2
Mapping	3	Testing materials laboratory	3
Machine Drawing	4	Machine drawing	4
Bridges	6	Mapping	3
Total	32	Bridge design	6
		Total	32

Third Year.

River and harbor improvements.	5	River and harbor improvements.	5
Railroads	3	Railroads	3
Sanitary engineering	4	Sanitary engineering	2
Industrial economy	2	Industrial economy	2
Engineering law	1	Engineering law	1
Bridges	8	Street tramways	2
Railroad drawing	4	River and harbor improvement drawing	4
Thesis	6	Railroad drawing	4
Total	33	Sanitary engineering drawing	6
		Thesis	6
		Total	35

Engineering practice whenever practicable.

MINING ENGINEERING COURSE.

First Year.

First Semester.		Second Semester.	
Geology	5	Mineralogy	4
Surveying and mine surveying	6	Surveying	6
Chemical analysis	12	Chemical analysis	12
Mechanical drawing and descriptive geometry	6	Topographical drawing	3
Applied mechanics	2	Blow pipe analysis	4
Total	31	Hydraulics	2
		Strength of materials	2
		Total	33

Second Year.

Mining	4	Mining	4
Metallurgy	2	Metallurgy	2
Petrography	6	Chemical analysis	12
Chemical analysis	10	Ore dressing	2
Ore dressing	2	Economic geology	5
Building Construction	1	Building Construction	1
Elements of mechanical engineering (machine design)	4	Steam and gas engines, boilers, etc.	2
Elements of electrical engineering	2	Machine drawing	4
Machine drawing	4	Mechanical metallurgical technology	2
Total	35	Total	34

Third Year.

Mining	2	Mining	2
Metallurgy	4	Metallurgy	4
Metallurgy of iron and steel	2	Metallurgy of iron and steel	2
Assaying	2	Metallurgical experiments	4
Practice in assaying	8	Engineering experiments	2
Design of mining plants	5	Mining laws	2
Design of metallurgical plants	5	Design of mining plants	5
Design of iron and steel plants	5	Design of metallurgical plants	5
Total	33	Design of iron and steel plants	5
		Total	31

Thesis time is allowed in design in third year. Engineering practice whenever practicable.

All the university work is conducted in English with the exception of Chinese classics.

Examination of the courses of study will show that they are very similar, both in subjects and hours allowed, to courses in the various American technical schools. Exactly the same text-books are used as in the American institutions. The quality of the work compares favorably with that the writer has seen in the smaller American institutions, but is not so thorough as the work in the larger ones such as Massachusetts Institute of Technology, Cornell, Columbia and some others.

The courses in engineering practice in civil engineering have been given by summer school work in railroad and hydrographic surveying. The summer school term is two and one half to three weeks each summer. It is required of all C.E. students.

The courses in engineering practice in mining engineering have been given by trips of inspection to mines and mine survey work in mines kindly placed at the disposal of the University by the owners. This work has lasted for three to four weeks during the year. It is required of all M.E. students.

The subject of physics is not included in the curricula, as it is supposed to be given in the high school. Up to the present time it has been given, along with elementary chemistry, by the University faculty, but is given as a preparatory subject in a preparatory year. This preparatory year is not

part of the regular work and will be omitted as soon as the secondary schools reach a higher standard. Mathematics through the calculus has been given in this preparatory year and later will be given in the high school.

Many of the students expect to go to America or England to study after leaving the University. After the time spent abroad they expect to return to China to teach or do engineering work.

A brief summary of some data which was obtained from the students by the writer is given.

GEOGRAPHICAL DISTRIBUTION OF STUDENTS.

Province.	Senior Class.		Junior Class.		Freshman Class.		Total Number of Students from each Province.			
	M. E.	C. E.	M. E.	C. E.	M. E.	C. E.	Senior Class.	Junior Class.	Freshman Class.	Total.
Chili	1	2	5	2	14	12	3	7	26	36
Chiang-su	3	2	2	0	4	2	5	2	6	13
Che-chiang	1	3	1	0	0	1	4	1	1	6
Fu-chien	1	0	0	4	1	0	1	4	1	6
Kwang-tung	1	0	2	1	0	1	1	3	1	5
Anhui	0	1	1	1	0	0	1	2	0	3
Hupei	0	0	0	0	0	1	0	0	1	1
Pekin (capital)	0	0	0	1	1	1	0	1	2	3
Total in classes	7	8	11	9	20	20*				73

Class.	Age Statistics. Age in Spring 1910.			Years that English has been Studied. Spring 1910.			Number Expecting to go Abroad.
	Oldest.	Youngest.	Average.	Longest.	Shortest	Average.	
Senior							
M. E.	30	18	24	10	8	9	8
C. E.	30	23	25	10	7	8.5	
Junior							
M. E.	27	21	24	11	6.5	9.5	5
C. E.	31	22	25	11	6	8.5	
Freshmen							
M. E.	34	22	26	9	6	7.5	8†
C. E.	29	22	25	10	6	7.5	

* Data for eighteen students given.

† Many are undecided.

A study of the map of China shows that all the provinces mentioned are on the coast except two—Anhui and Hupei. The Yangtze River, the main artery of commerce to the interior, passes through these. This shows the fact that foreign education and methods have not pentrated very far at present. The foreign influence is gradually going inland and new government schools, arranged according to foreign ideas, are being established continually.

Examination of the age statistics shows the same average age for all classes, although they graduate at different times. This is probably due to the changes made by the board of education from time to time, these changes gradually increasing the average age. At present it is practically impossible for a student to enter the university much under twenty-three years of age, so the average age will continue at twenty-four to twenty-five. This is higher than the American average.

The number of years that English has been studied is interesting, since all the work is conducted in English and the students are expected to take notes just as in any American college. Here the average shows the difference in length of time of study. The senior and junior classes are very nearly alike. (They graduate six months apart.) The freshman class is one and one half years behind the junior class. It requires six to eight years preliminary study of English to be able to do the work of the University and nine to ten years are better.

The students cannot understand a lecture if it is delivered rapidly, but most of them have no difficulty if it is delivered slowly and disinctly. The students have a better knowledge of technical English than they have of ordinary conversation.

The building and equipment of the University consists of thirty-nine buildings, scattered over an area of 1,500 feet by 800 feet. Six of these are two stories in height and the rest are one story. The two-story buildings are four double professors' houses, the president's house, and the main building, which has twenty-five rooms. The professors' houses are heated by furnaces and the main building is heated by exhaust steam from the lighting plant. The rest of the buildings are heated by stoves.

The equipment for instruction is the best of any belonging to the imperial universities in China, if not the best in China. (Some of the missionary colleges have very good equipment.) The equipment is much better than some American universities I could name.

The physical laboratory has a complete equipment for twenty-five students in a strong course of advanced high school physics. The apparatus is sufficient for tests in mechanics, hydraulics, heat, light, sound, optics, electricity and magnetism.

The chemical laboratory has been remodeled this past year and now has two large rooms with the best modern equipment imported from America and Germany. The apparatus includes a gas plant for making gas for the laboratory. The laboratories have desk room for fifty students at one time.

There are two large well-lighted drawing rooms with individual desks to accommodate seventy-five students at one time.

The surveying department has a large assortment of the best American instruments, consisting of rods, chains, tapes, levels, transits and plane tables. Twenty students can be sent out in the field at one time.

The testing materials laboratory has one 50,000 Kilo Riehle Universal Machine, one 30,000 Kilo Riehle hydraulic transverse machine, both with power drive. There are sufficient scales, moulds, etc., to accommodate eight students at one time in cement and concrete mixing and testing. In addition there are the usual assortment of small instruments necessary in any well equipped laboratory.

A hydraulic laboratory has been started with a small steam pump, motor-driven turbine pump, water wheel, water turbine, water meters, pressure tank, orifices, weirs, nozzles and piping for the measurement of the flow of water in piping. A modern water meter for gauging the velocity of water in rivers belongs to the laboratory. In addition there are the storage tank for water, scales, weighing tanks, etc.

There are a small machine and wood working shop and a pipe shop for the use of the professors and for small re-

pair work around the University. These shops have a power lathe, drill press, grindstone, hack saw, complete outfit of small tools, work benches, and pipe fitting machinery. Power is furnished by a small gasoline engine.

The mining department has a museum containing a collection of the common minerals from all over the world, also a small collection of jewel stones, fossils and the shells of living animals. For petrographic work there are two lathes for cutting and grinding rock slides and four microscopes. In addition there is a mine tunnel 300 feet in total length, including bends, of 5 feet by 6 feet 6 inches cross-section. This tunnel is timber lined and has two shafts leading to the surface. It is placed 15 feet below the surface of the ground.

The metallurgical department has the following equipments: 6 Denver Fire-Clay double-muffle furnaces, two Ainsworth Culton balances, accessories for assay work, one small reverberatory furnace, one small cyanide plant for the treatment of gold ores, one small filter press, metallographic microscope, pyrometers and calorimeters for the investigation of fuels.

The departments have three projecting lanterns, two of which require electricity and one small one requires kerosene. One of the large ones is the latest model reflectoscope.

The University has its own lighting plant consisting of 2 Babcock and Wilcox boilers, without superheaters; two 25 horse-power Buffalo Forge Company's horizontal engines direct-connected to 15 kilowatt Siemens direct current 110-volt generators. In addition to the ordinary auxiliaries there is a storage battery to supply current part of the time.

By next summer it is hoped to have our own water system consisting of filtration plant, storage tank and distribution system.

The library is small at present and is housed in a very poor building. It contains all the leading engineering magazines, but has very few books. At present we do not have more than five hundred books on engineering in the library. The University is buying books rapidly and within two years the

library will have copies of all the engineering books of any value. A new fireproof library building is to be built within two or three years.

This concludes this sketch of the Imperial Pei-Yang University. It shows that China has made a start in engineering education. The beginning is small but the prospects are good for a large amount of excellent work in the years to come. At present we cannot secure students with the proper training, so our number is small. It seems from the outlook now that this condition will exist for two or three years more and then we will have more students than we can handle with our present equipment.

Written discussion on the above paper, if received before Dec. 1, will, with the approval of the Editing Committee, be printed in the PROCEEDINGS. Contributions should be brief and interesting and should add something to the subject.—ED.